

# Progress in EUV Collector Technology at SAGEM

Roland GEYL, Renaud MERCIER YTHIER, Xavier BOZEC, André RINCHET  
**SAGEM SA - REOSC High Performance Optics**

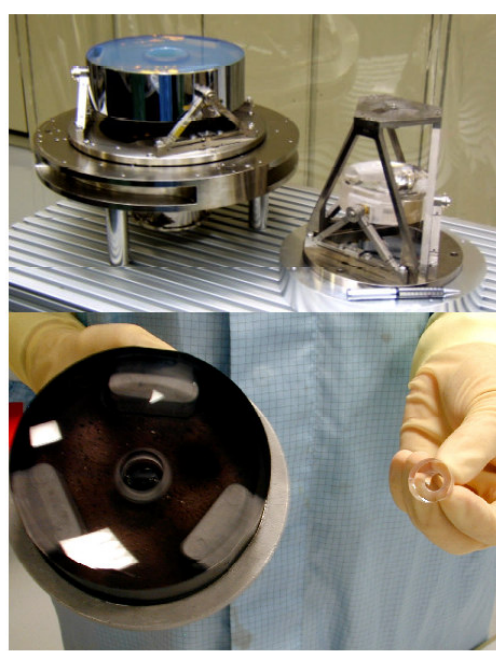
Avenue de la Tour Maury  
91280 Saint Pierre du Perray - France  
contact : renaud.mercierythier@sagem.com

This poster presents SAGEM various line of R&D effort toward precision optics for EUV applications. Generic EUV optics background, and specific progress in designing and manufacturing of EUV mirrors and collectors are highlighted.

## SAGEM Background in EUV Optics

### • SAGEM participates to the European EUV R&D effort

2000-2002 PREUVE project with Leti - Manufacture of the BEL  
2002-2004 EXTATIC and EXTUMASK programS within EU MEDEA+ frame  
2004-2006 More Moore program within EU ISTframe  
2006-2007 Eagle Program (European consortium of manufacturers led by ASML)



### • EUV optics example : The BEL Schwarzschilds

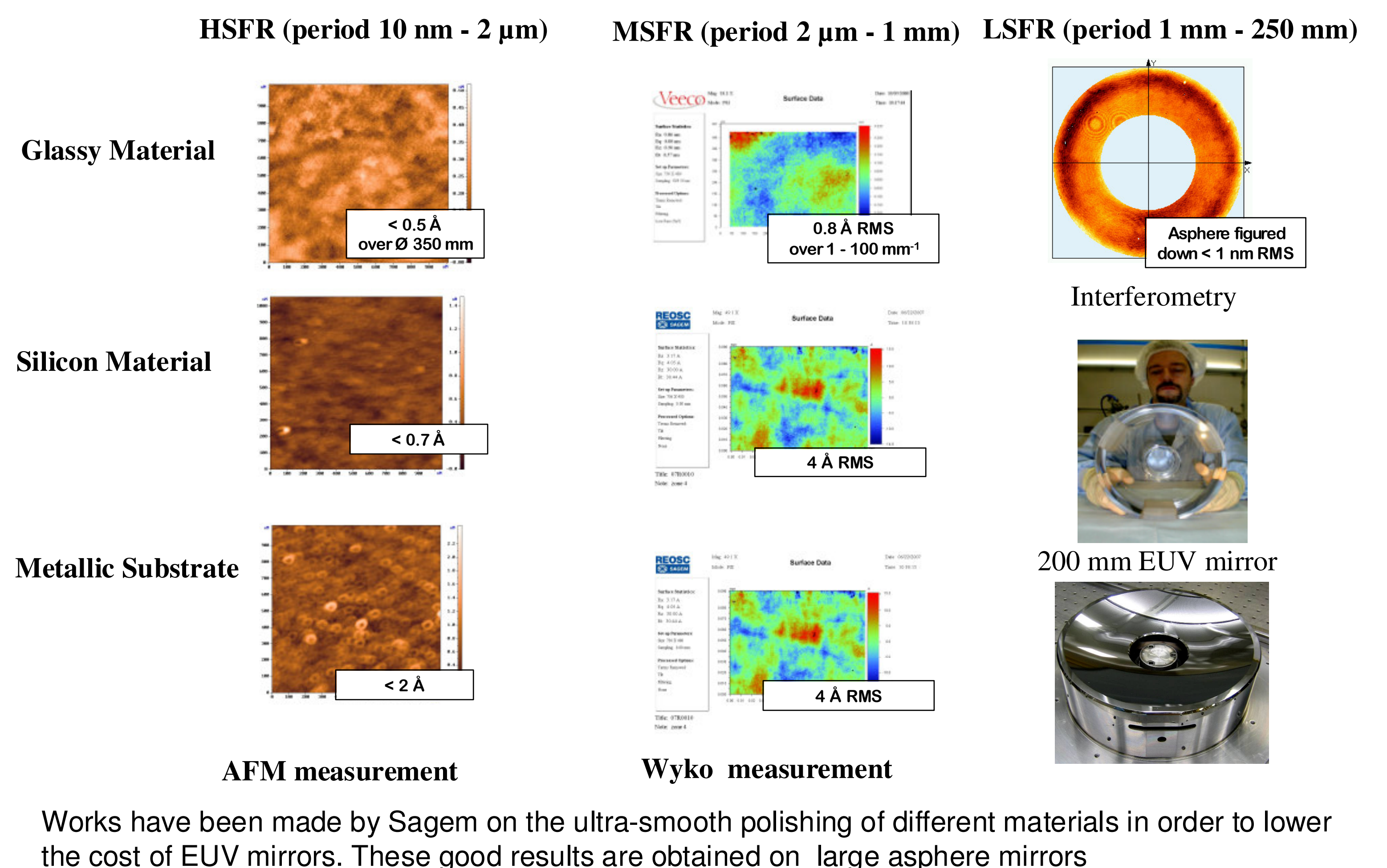
Design : FOV=100  $\mu$ m, NA=0.32, Aspherized mirrors,  
Mag : 10x, large mirror diameter 220 mm

Optical performance :

< 0.15 nm RMS HSFR (per mirror)  
< 0.20 nm RMS MSFR (per mirror)  
< 1.8 nm RMS transmitted WFE (full system)

## Ultra Smooth Polishing

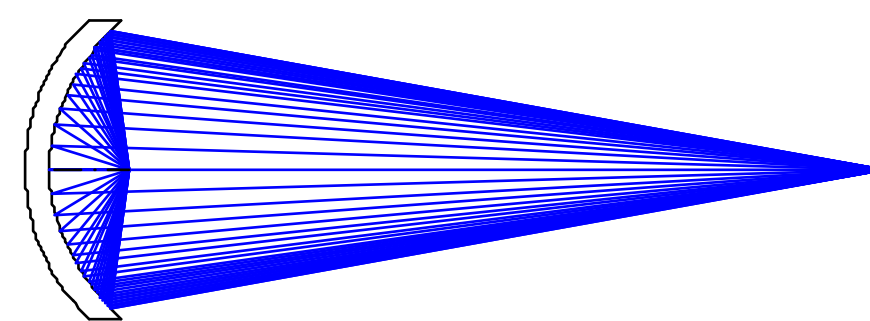
Within Eagle, specific polishing development has been conducted on different substrates.



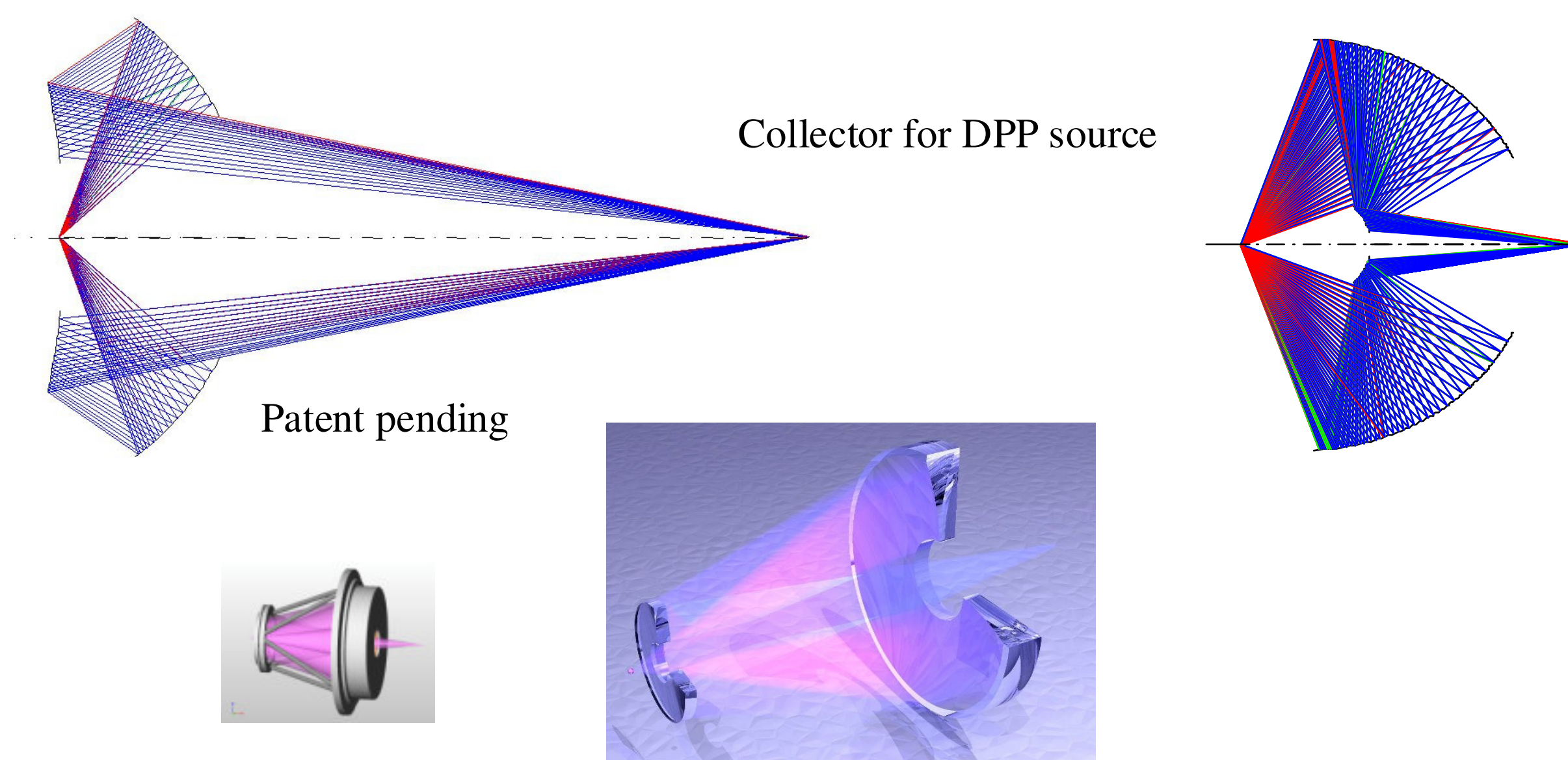
## Collectors Design

### • Collectors for DPP and LPP source (Eagle studys)

Collection angle : up to 80°  
Throughput up to 45 % of  $2\pi$  sr  
Good image quality thanks to mirrors aspherisation  
Design compliant with foil trap for debris mitigation  
Uniform pupil fill compared to grazing incidence collectors  
Easy cooling implementation on mirror's rear side

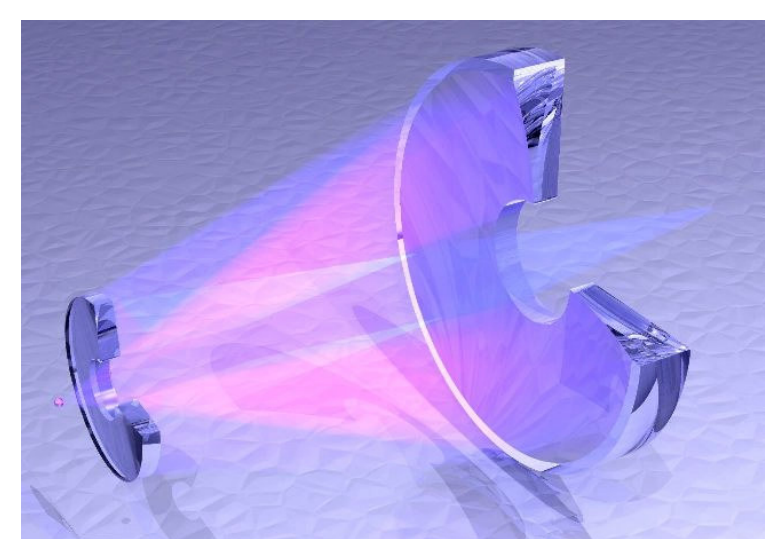
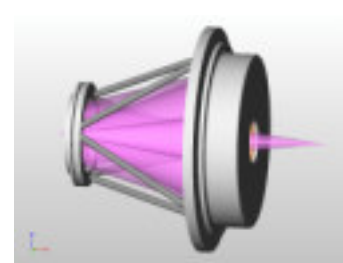


Collector for LPP source



Collector for DPP source

Patent pending



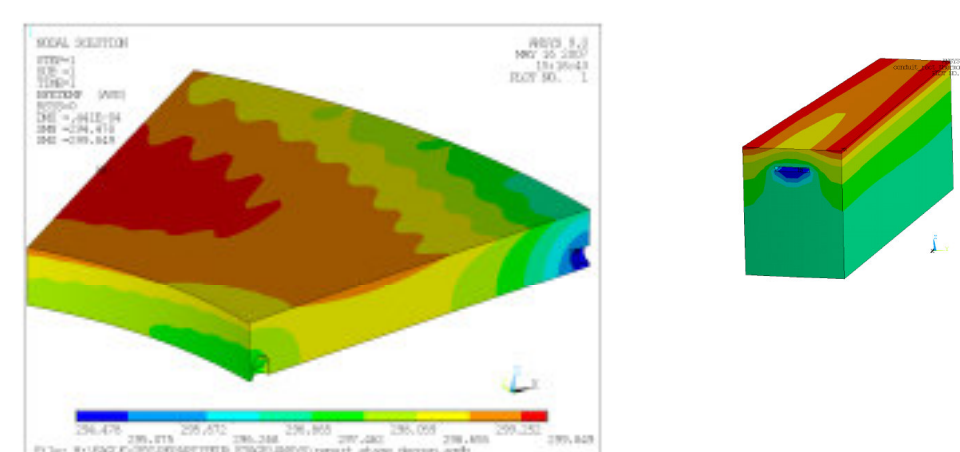
## Substrate Machining & cooling

Sagem has recently conducted extensive technological studies and breadboard activities on low cost EUV collector substrates

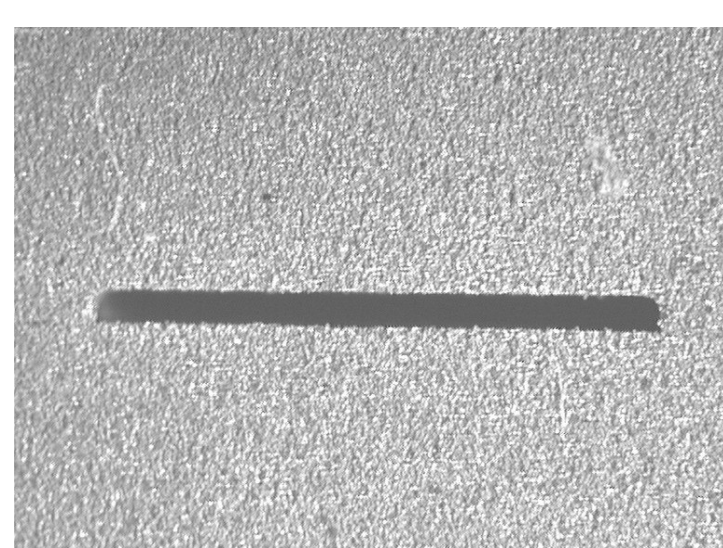
### • Substrate materials for EUV mirrors

Sagem has experience with the following substrates :

- Glassy material (Zerodur, Fused Silica)
- Silicon or SiC
- Metal materials



Thermal study with water cooling



Slim channel technology

### • Cooling and machining

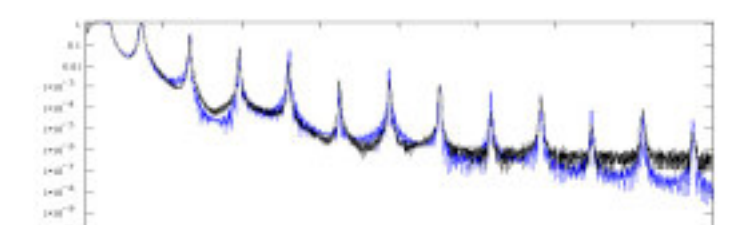
EUV mirrors close to the source receives a large flux  
Efficient cooling has been studied by Sagem in the scope of Eagle

Small channels are machined very close to the optical face allowing an efficient cooling to ambient temperature without degrading the optical performances

## EUV coating

Sagem is actively preparing its capability to transfer EUV coating technology to its large coating facility for industrial production of large normal EUV collectors.

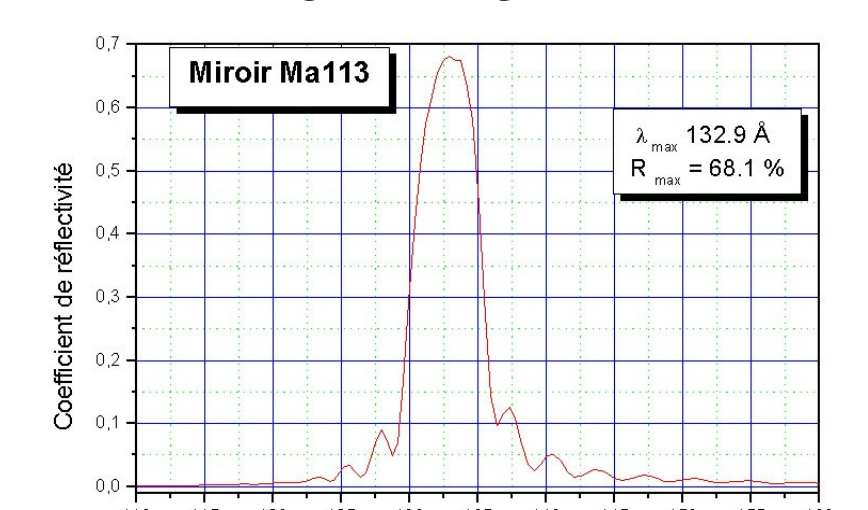
- Development made with Paris Institute of Optics
- 200 mm diameter mirrors can be coated.
- Works on enlarged capabilities initiated.
- Technology : Magnetron sputtering or IBS
- Design : stack of 40 Mo/Si bi-layers, stability reinforced with interdiffusion barriers
- Gradient : required when incidence variation exceeds a few degrees
- Metrology :
  - Small angle X ray reflectivity
  - Diffuse X ray scattering
  - AFM
  - EUV reflectometry



X ray reflectivity vs i

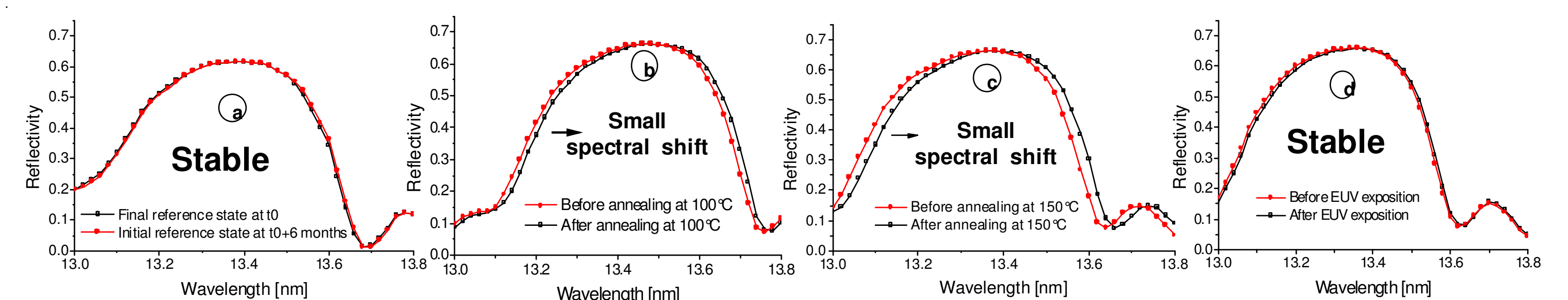


Coating with gradient



Measured at Lure Synchrotron

• In 2007 qualification of an EUV coating with interdiffusions barriers have shown its stability after annealing, EUV exposure, thermal cycling and humidity exposure. Other designs under evaluation.



• In the scope of Eagle, good stability of this coating has been shown after annealing at 300 °C

## Conclusion

- Thanks to Eagle studies and recent contracts, big progress has been made by Sagem in the polishing, coating and cooling of ultra smooth mirrors for EUV sources.
- Complete solutions can now be proposed for EUV mirrors and collectors, in line with the stringent requirements required by the EUV field.